Developing the Three Levels of Learning in Crisis Management: A Case Study of the Hagersville Tire Fire

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The three levels of learning from crises are behavioral, paradigmatic *and* systemic. *Based on a case analysis, the first two levels of learning are integrated into the organizational structure; the third occurs at the individual level. Discussed are tools available to managers to integrate learning potential into their organizations.*

Introduction

Management is now more aware than ever that activities in crisis management go well beyond disaster recovery planning and preventive strategies [5]. Increasing numbers of scholars and managers alike are realizing that the experience of crisis, despite its negative aspects, acts as a powerful trigger for change and learning [11,14,15,16,18]. This is due to the fact that crisis has potential revelatory and change effects [18]: the potential revelatory effect occurs as crisis demonstrates the tight and systemic relationships existing among issues and stakeholders, relationships which might have been less visible before the crisis; the potential change effect occurs as the emergence of a crisis encourages the need for different policies and strategies.

In this article, we will present the three levels of learning managers can derive from the experience of crises: the *behavioral*, *paradigmatic* and *systemic* levels. We will provide concrete examples of these different levels through a case analysis: the Hagersville tire fire, which took place in Ontario in 1990, the largest tire fire experienced so far in North America. We have chosen a tire fire since these fires are particularly difficult to manage, some burning for up to eight months, and since they cause lasting economic, social and ecological problems. They are also relatively common in the United States, as indicated in Exhibit 1. After presenting this case, we will discuss the different levels of learning it triggered, and we will propose several tools for fostering the third and more difficult level of learning in organizations.

The Hagersville Tire Fire

When Carry Mathews and her mother saw the flames in the middle of the night, they knew what to do: evacuate the cattle and leave the farm as fast as possible. They had been expecting it for years, and now here it was: millions of tires on fire, 500 feet down the road. The first volunteer firefighters quickly took action and continued to fight the flames for more than two weeks, with professional assistance from all over Ontario, Canada and the United States. The Hagersville tire fire would be remembered by the community for years.

EXHIBIT 1. SOME MAJOR TIRE FIRES IN THE UNITED STATES

	Winchester Virginia	**Everett** WA	**Somerset** Wisconsin	**Hudson** Colorado	**Catskill** New York	**Grantsville** Utah	**Washington** PA	**Fort Wayne** Indiana
Year	1983	1984	1986	1987	1989	1992	1997	1997
Tires (millions)	5	1	8 to 9	1 to 2	NA	1	1.7	0.5
Fire-fighting methods	controlled combustion	water	water	soil covering	water and soil covering	controlled combustion	NA	controlled combustion

EXHIBIT 2. THE HAGERSVILLE TIRE FIRE: MAIN FACTS	
Date	Feb. 12 to Mar. 1, 1990 (17 days)
Tires	12 to 14 million
Type of storage	1 huge pile, the height of a four-story building
Surface-area	5 ha
Contamination	Extensive: air, soil, shallow and deep groundwater, spring, vegetables and plants
Involvement	384 agencies or groups, 35 professional firefighters and more than 180 volunteer firefighters
Evacuation	1,200 people (including Natives) /3 days. 300 people/15 days.
Fire-fighting method	Cooling the pile, controlling flames and fumes Separating small batches of tires Classical fire-fighting with water and foam
Equipment	Fire-trucks, breathing apparatus, automatic water hoses, foam, heavy-duty materials, water bombers, water pumps, water treatment plant, monitoring wells, air/wind monitoring systems...
Trigger event	Arsonists (teenagers)
Cost	Around $100 million Canadian

It is still known as one of the biggest environmental crises in Canada and the largest tire fire in North America, involving nearly *14 million tires*. The partial combustion of tons and tons of rubber, wires and other compounds, mixed with water and foam, produced widely spread toxic fumes, as well as several thousand gallons of oil contaminated with carcinogenic chemicals. Exhibits 2 and 3 summarize the main facts of this event and present a linear description of the emergency [20, 23].

The First Level of Learning: Behavioral

Although the exact process of learning at the individual and organizational levels is still debated [1, 2, 21], there is some consensus that different levels of learning exist, due to the pioneer work of Gregory Bateson [3,13]. The first level is often the most obvious. We call it behavioral learning. Its aim is to pursue the same goals as other levels simply by modifying or amplifying the means used. It is not internalized by an individual or by a group but is enforced and maintained by external control, through rules, regulations or technological systems. As summarized in Exhibit 4, changes that occur through this type of learning are often administrative, technological or legal in nature. They are derived from a concrete event but are only fragmented answers to a complex situation.

However fragmented, these answers are nonetheless important and generally effective in an emergency situation. The main lesson from Hagersville is the fact that firefighters learned how to put out a tire fire for the first time. The strategic choice to fight the fire by using water and by breaking up the pile from the very beginning allowed them to overcome the flames in just two weeks. This is a great achievement since tire fires were known until then to be nearly inextinguishable. Other lessons, as summarized in Exhibit 4, include the importance of clarifying roles and the need for many different actors, organizations and governmental agencies to coordinate their actions when responding to a crisis.

However, this approach to extinguishing the fire had serious and unexpected systemic side-effects. Water and foam overflowed the site, forcing environmental experts to dig trenches and to install a wastewater treatment plant from scratch in a nearby field. Although this choice of intervention reduced the duration of the fire, it could also have worsened air contamination due to partial combustion producing more carcinogenic chemicals. Partial combustion can also cause ground contamination, by increasing the infiltration of contaminated oil. Furthermore, the increase in governmental regulations for tire sites (i.e., enhanced fencing, required emergency water tank, spreading of the tires over a larger surface, and so on . . .) was met with great resistance from the private sector, these regulations being external pressures, not internal choices. This shows another limitation of this level of learning. Indeed, the legal battles over these regulations — pursued for years by the owner of the Hagersville site prior to the fire — did not diminish the risk of such a crisis happening.

The Second Level of Learning: Paradigmatic

The aim of the second level of learning is to pursue the same goals as the first level, but with the possibility of radically changing the means used. It can lead to a certain internalization of issues by the actors themselves, as they are not only acting under constraints imposed by an external agency. This level also allows different stakeholders to take into account a wider range of issues. Furthermore, individuals can possibly shift from one paradigm to another. For instance, as indicated in Exhibit 4, the creation of a public response team during the Hagersville fire allowed the public to be directly informed on a daily basis, not through the media only. It also allowed them to express their concerns. This can be viewed as a true paradigm shift.

Normally, a lead agency would assign a spokesperson to deliver the officially filtered information. However, the type of learning evident during the Hagersville event also favored the useful involvement of local people, who could share their unique and diverse knowledge about local resources. For instance, this kind of direct collaboration led to the discovery of special water treatment equipment at a local brewery, which diminished the foam created during the firefighting. It also decreased the stress level of evacuees, by diminishing the rumors surrounding the crisis and by putting the sensationalism aired by the media into context.

Another example of a paradigm shift is demonstrated in the government's reconsideration of alternatives for recycling used tires. Until the Hagersville fire, the Ministry of Environment was firmly against the incineration of these tires, with the support of environmental lobbyists. Incineration was then merely considered to be the destruction of a non-renewable resource and was suspected to spread carcinogenic particles in the environment. Furthermore, while incineration was banned, tire recycling projects showed no real economic viability. Recycling plants in Ontario received little support, be it financial, commercial or technological. Though the province of Ontario had set a $5 tax on used tires in 1989, the collected funds were almost completely integrated into the general provincial budget and no serious efforts were developed for recycling. For example, in 1996, out of the 125 million used tires generated per year in Ontario alone, close to 50 percent were sent

EXHIBIT 3. A CHRONOLOGICAL ACCOUNT OF THE HAGERSVILLE EMERGENCY

February 12, 1990: The fire bursts out around 1 A.M. in a tire storage depot considered an "environmental threat" by the Canadian authorities. 100 local firefighters quickly take action. 600 people are advised to evacuate.

February 13-15, 1990: Fumes rise one mile in the air and can be seen from over 60 miles away. The emergency becomes regional. Professional forest firefighters arrive on site. Experts and people worry about contamination of air, water and crops, fueling a media hype about the event. The contaminated oil begins to flow due to water, fire-retardant foam and decomposition of burnt tires. The site is qualified as "hell" by firefighters, including oily mud, wires from radial tires, heavy toxic fumes and high temperatures.

February 16, 1990: The medical authorities stop the operations in order to equip firefighters and vehicle operators with breathing apparatus. Some political confusion occurs about the lead on site (federal vs. provincial). Provincial authority keeps the lead on the emergency. A regional warning is sent to suspend humans and animals from drinking the underground water.

February 17-20, 1990: Toxic compounds are detected in the fumes, including PAH (Polycyclic Aromatic Hydrocarbons), renowned to be highly carcinogenic. Air and water monitoring continues. The operations are stopped to deal with the massive flow of effluents (more than 50 000 gallons of contaminated oil). A Joint Response Team is created to coordinate the emergency response. Facing bitter criticisms from residents, involved ministries start discussions about the issue of used tires.

February 21-28, 1990: Water bombers, heavy-duty vehicles and firefighters are used against the fire. The U.S. embassy starts to worry about the potential trans-border contamination. The operations are regularly interrupted to allow the pumping and treatment of the effluents. Greenpeace qualifies the fire "one of the worst environmental disasters in North American history." Water treatment ponds are built on site.

February 29 - March 1, 1990: The fire is out. Firefighters are looking for fumes and possible hot spots. Constant air, soil and water testing are continued. The site is declared dangerous and is strictly forbidden to the public.

March-April 1990: The Ontario government launches a monitoring program for the tire depots all over the province. Treatment of contaminated oil is continued as carcinogenic chemicals are still detected in the environment. Researchers in chemistry and ecotoxicology declare that, on a theoretical basis, the environmental impact will not be as serious as expected. The provincial government declares that the fire is no longer a threat to human health, local fauna and flora. The arsonists are arrested.

July 1990: An article about tire sites is added to the Fire Marshals Act of Ontario. Many lawsuits are launched, abandoned after awhile or still pending, with no real chance of compensation.

1998: On rainy days, oily pools still appear. The site looks like every surrounding field, apart from a small hill of discarded tires buried in slightly contaminated soil. Several families have moved. Access to the site is still forbidden. The risks and consequences associated with the fire are still debated.

to tire sites. Furthermore, 18 percent of all used tires were resold in the province or abroad and 15 percent were retread to produce truck tires [24]. These figures suggest that for around one-third of the tires not sent directly to tire sites, the strategy was only to postpone the end of their life-cycle instead of finding a real solution for their treatment. This situation is typical of the used tire industry in other Canadian provinces and in the United States. U.S. figures add another dimension to the problem: with about 250 million used tires generated annually (approximately one scrap tire per capita), the country possesses between 700 and 850 million scrap tires in widely disseminated stockpiles [22].

There are three major markets for used tires: Tire-Derived Fuel (generally in cement kilns, pulp and paper mills or electricity-generating plants), the development of new products (rubber-modified asphalt, reshaped tires, athletic fields) and civil engineering applications (landfill cover, artificial reefs, road bed supports). Used tire markets have increased since the mid-eighties, but even in 1995, they could only absorb around 70 percent of the annual generation. This gives no real solution to the management of tires already stockpiled [22]. The lift of the ban on incineration in Ontario in 1996 was triggered by lessons learned from the Hagersville crisis and demonstrates a paradigm shift. However, even this kind of decision gives only a partial and limited answer to the used tire issue without dealing with the very roots of the problem.

The Third Level of Learning: Systemic

The aim of the third level of learning is the most complex and demanding of all. Both means and ends can be modified. Fundamentally, this type of learning allows individuals to acknowledge the influence of paradigms themselves, triggering the choice of strategies derived from different paradigms. It also often leads to accepting the paradoxical nature of complex systems and finding more cautious means of intervention. There is greater awareness of the possibility of doing even worse when taking action.

This type of learning requires an awareness of the systemic nature of complex problems. This includes the many different issues at stake and the many different stakeholders involved, their complex interrelationships with their low and tight coupling, as well as their amplifying and constraining effects. It also includes an awareness of the complex interrelationships between economic, social, technological and environmental issues [15, 18]. Exhibit 5 presents a simplified systemic graph of the Hagersville crisis process, displaying the main stakeholders, the main issues, the low and tight coupling (including the amplifying and constraining effects among them), and the relationships between social and natural systems.

As clearly shown in Exhibit 4, this type of learning is mostly derived from and integrated at the individual level. It is not often institutionalized. In our study, we have found that only 15 percent of individuals are able to achieve this type of learning. One exception should be noted — the burgeoning of Industrial Ecology.

The core concept of Industrial Ecology is to imitate in industrial matters the processes found in nature. Through notions such as Life Cycle Assessment, Design for the Environment, Industrial Symbiosis or the Eco-Parks, this approach attempts to propose economically, technologically and ecologically viable solutions for reducing the waste stream by addressing its roots, utilizing used items for raw material [10, 25]. This new vision was born partly in General Motors' Research Laboratories and has since been partially implemented in the European car industry in firms such as BMW, Volvo and Volkswagen [8]. With regard to the tire industry, Michelin, the world leader, proposed a green tire with a longer life span of 80,000 miles and is now attempting to retrieve its own used tires. However, the company must admit that tires are not recyclable in the strict sense of the term for several reasons: the irreversibility of the vulcanization process; the complex nature of the tire; the need to consider different economic, safety, durability and technical imperatives; and the fact that tires are made of artificial and natural rubber and fibers, wires, multiple chemicals and even ceramic particles [17, 26]. Considering these constraints, tire

manufacturers can only partly implement the Industrial Ecology process. But progress is being made to better integrate the imperatives of cost, safety, durability and technological know-how when considering viable treatment of used tires.

The third level of learning also leads individuals to question the *roots* of the problem. For instance, the over-use of the automobile in our modern societies leads to the massive production of used tires. Individuals using this level of learning favor the use of other means of transportation, such as bicycles, buses, planes or trains. The development of high-speed trains in Europe and Japan is an example of changes in vision and policies. These individuals are also more inclined to recognize that any kind of transportation has its advantages and disadvantages, and can lead to both progress and tragedy. For example, the massive use of the automobile takes a tremendous human toll, claiming more than 250,000 lives worldwide per year, despite continuing progress made in car and road safety. It also contributes to a large degree to the pollution of cities and is responsible for the consumption of huge amounts of non-renewable energy [7, 12].

From this larger perspective, the viable management of used tires, as well as crises such as Hagersville, are themselves part of a larger and extremely complex problem our societies must face. Ultimately, such systemic questioning and learning should help identify obstacles that prevent stakeholders from modifying their usual activities when they are destructive. It should also prevent these stakeholders from proposing various unlocking strategies that would allow the deep changes revealed by the emergence of crises to be implemented. Exhibit 6 offers a simplified summary of such an approach.

The experience of crisis, despite its negative aspects, acts as a powerful trigger for change and learning.

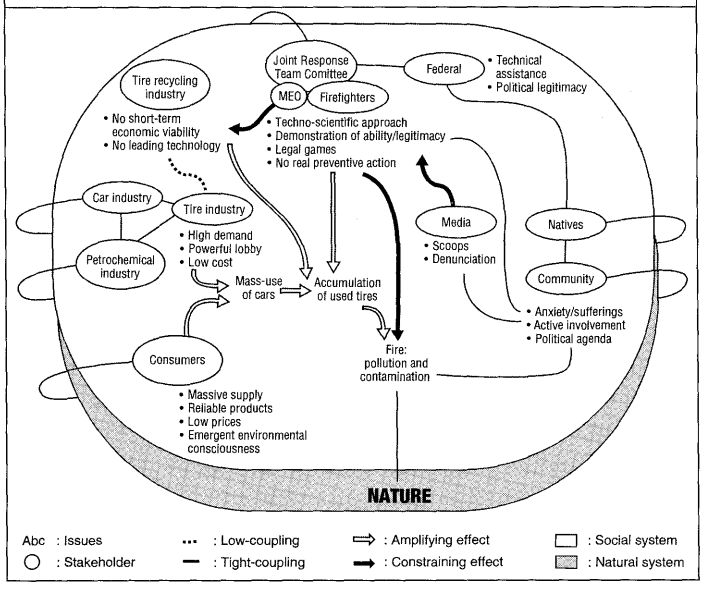
The fact that only around 15 percent of individuals are able to develop the third level of learning and that little of this learning is being institutionalized (readily used in organizations), also demonstrates the need to develop various strategies to diminish these shortcomings. Three particularly worthwhile strategies for managers are outlined below.

EXHIBIT 4. THE THREE LEVELS OF LEARNING AND THEIR DEGREE OF IMPLEMENTATION.

BEHAVIORAL	PARADIGMATIC	SYSTEMIC
Levels of implementation		
Institutionalized		
• Extinguishing a tire fire • Direct communication and involvement with the local community • Roles-coordination of emergency response (Joint response team committee) • Call to professional firefighters to deal with fire that could last more than a few days • Near-site presence of officials to ease financial decisions • Professional counselor for each fire-fighting department • Optimizing internal and external communication • Minimal insurance for tire storage • Changes in the Fire Code about tire pile-storage, fencing and water tank equipment.	• Working collectively • Placing people and environment concerns first • Establishing a public response committee • Taking the political dimension into account • Considering recycling as more than a mere economic issue • Studying recycling possibilities • Allowing the government to act even against the will of an owner of a used tire site in case of environmental threat • Using breathing apparatus for personnel • Accepting tire incineration	• Developing the notion of Industrial Ecology (still in an experimental stage)
Individuals only		
• Developing more faith in community spirit • Gaining confidence in one's ability to deal with critical events	• Being highly cautious about potential toxicity, such as burying potentially harmful soil in a protected waste site • Developing local expertise and integrating them with the work of other organizations	• Increasing the realization of the over-use of cars and encouraging the use of other means of transportation • Acknowledging that each choice has its advantages and disadvantages • Encouraging a more humble state when confronted with environmental issues • Developing a greater acceptance that crises are part of life • Encouraging existential courage to address the negative sides of industrial activities

Systemic Study. The first strategy consists of conducting a systemic study of a crisis. In other words, not confining oneself to analyzing only a few issues with the intention of quickly returning to the status quo known prior to the crisis. To conduct the systemic study of the Hagersville tire fire, the various reports written on this crisis were studied, the press articles were collected and analyzed, the site was visited and more than 30 people involved with the crisis were interviewed including people from all kinds of professions working in many different organizations [23]. It is particularly important not to confine oneself to a few perspectives, but to include *all* the issues that surface and to interview a number of people who do not belong to any organization. This counter-balances the wish for the political defense of institutionalized vested interests. In addition to compiling a chronological account of the crisis (Exhibit 3), a systemic graph needs to be drawn, showing the interrelationships among the different stakeholders and issues (Exhibit 5). Moreover, the different levels of learning, obstacles to learning and potential unlocking strategies (Exhibits 4 and 6) are particularly helpful for summarizing and communicating the results. Other examples of the systemic study of crises are available

EXHIBIT 5. STAKEHOLDERS AND ISSUES



elsewhere [18] and the methodology, following the principle of requisite variety [2], is described in other works [15].

Search Conferences. The second strategy consists of organizing one or several search conferences on the subject. These conferences, which would explore a complex issue and foster collective decisions, gather together the main stakeholders concerned with the issue. That would mean 50 to 80 people in one room. The power of this process is to bring together for the first time, people who are not used to talking and listening to each other, and who often think and act in very different ways. Once involved together in a collective quest, these people often discover affinities in their goals and common grounds of inspiration. While these conferences are still in the process of scientific evaluation, they have been used extensively, with encouraging results, in firms and organizations in Canada such as Environment Canada, Health Canada, Pollution Probe and more. They have also been used in U.S. organizations such as Kellogg, Revlon, Dow Chemicals, the Smithsonian and more. This process has been described in several works [6, 27].

Dialogue Circle. The third strategy consists of organizing a dialogue circle on the issue, gathering together 30 to 40 people from different backgrounds and organizations. While search conferences involve a three-day setting where decision-making can occur between different stakeholders on different priorities, the dialogue circles aim to uncover the basic assumptions and representations upon which decisions are grounded. They do this through a long-term exploration of at least 10 meetings of two hours each, scheduled over a period of several months. The process of dialogue is slow and open, and as free as possible of the usual rhetoric and power games. It allows members to better understand their own basic assumptions, as well as those of others, and to build collective meaning together. At the same time, members can respect their individual differences. This is supposed to happen through volunteer participation, with reciprocal attention and special awareness of the subtle relations between mind, body, feelings, culture, decisions and actions. Such circles have been formed with good results in many organizations, such as CBC, Ford, Human Resources Canada, IBM, the Royal Bank, Xerox and more. The process of these dialogues has been described in several works [4, 21].

Conclusion

The need to better manage, prevent and learn from events such as the Hagersville tire fire is paramount. The number of such crises and their massive financial, social and/or ecological impact are simply too huge to be ignored.

EXHIBIT 6. MAJOR BLOCKS AND UNLOCKING STRATEGIES

STAKEHOLDERS	BLOCKS	UNLOCKING STRATEGIES
Firefighters	• No real environmental concern • Classical water-based fire-fighting approach	• Education in ecology • Specialization in chemical emergencies
Joint Response Team	• Difficulties to start working together	• Role-clarification, joint simulations
Ministry of Environment	• No clear position on the used tire issue • Incineration ban	• Search conference on used tires • Dialogue about environmental priorities
Federal Government	• Unclear role in the emergency	• Develop Prime Ministers' meetings on environmental issues • Joint simulations with provinces
Community	• Unable to prevent the fire • Anxiety about long-term pollution	• Active vigilance to environmental threats and education in ecology • Psychological counseling
Consumers	• Over-use of cars, of petro-chemical products, of non-recyclable goods	• Environmental information, involvement, lobbying • Education on risks incurred • Develop alternative means of transportation
Media	• Lack of precision/objectivity • Focus on catastrophic aspects	• Education in ecology and scientifically complex issues • Reinforce the ethics of the profession
Recycling industry	• Limited markets • High supply costs	• Subventions for R&D • Taxes on used tires
Tire (and car) industry	• Profit-centered • Limited environmental involvement	• Assessment of the negative sides of industrial activities • Develop the notion of industrial ecology • Replace safety and ethical issues within the other ones considered

Tire fires do not even have the advantage to renew the ecology, as forest fires do, despite their negative impact on people and property [9]. Perhaps the brightest side of tire fires is the impetus for change they can potentially trigger, allowing managers and employees alike to be more aware of the negative aspects of their industrial activities and cultural habits.

With this article, we hope we have been able to communicate to the reader that activities in crisis management, concerning tire fires or other such crises, are not confined to better disaster recovery planning, leading to a quick return to the status quo. Conversely, we hope we have been able to communicate that all three types of learning are necessary in crisis management. We do need to encourage the first level of learning, since it leads to better regulations, technologies, controls or training, despite the external nature of these strategies. We also very much need to encourage the second level of learning, helping managers and employees alike reexamine their old paradigms and modify them, when necessary. And, lastly, we need to encourage the third level of learning, leading to a better systemic understanding and better strategies when dealing with very complex issues without, however, falling for the desire for perfection.

Efforts in crisis management are fundamentally ethical in nature [18]. Their aim is to manage our organizations for their financial health, as well as for the viable health of people, communities and the natural world. As such, these efforts require more than an enhancement of our intellectual capacities, striving for more systemic understanding and strategies. They also require that we develop existential courage, both individually and collectively. This helps address the negative aspects of our managerial and industrial activities, a particularly threatening task indeed, as it touches the very core of the human condition. It also requires an awareness of the potentially negative aspects of individual and collective activities, and can lead not only to changing the means traditionally used but the general goals themselves.

It is only through the development of courage that we can maintain and/or regain the existential, humanistic and transcendent meaning that managerial and regular work in organizations is supposed to generate for ourselves and others. We hope that, with the help of existential thinking, processes and tools [19], managers will be able to better develop this ethical and meaningful purpose in their organizations.

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